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SUPPLEMENTARY INFORMATION

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Slow escape decisions are swayed by trait anxiety

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Supplementary Information

Supplementary methods

It is important to note that participants had a larger time window in which to respond in the slow predator condition, thus, while the variances of the empirical attack times were not significantly different (all subjects experienced the same empirical attack times; fast vs medium: $F(24,23) = 1.36$, $p = 0.464$, ratio of variances = 1.36, *95%CI* = [0.59, 3.1]; medium vs slow: $F(23,22) = 0.57$, $p = 0.186$, ratio of variances = 0.57, *95%CI* = [0.24, 1.32]; fast vs slow: $F(24,22) = 0.78$, $p = 0.537$, ratio of variances = 0.77, *95%CI* = [0.33, 1.77]), the variance in escape distances was not equal across predator types, neither across subjects (variances across median FIDs, fast vs medium: $F(26,27) = 0.25$, $p < 0.001$, ratio of variances = 0.25, *95%CI* = [0.12, 0.55], medium vs slow: $F(27,27) = 0.27$, $p = 0.001$, ratio of variances = 0.27, *95%CI* = [0.13, 0.59], fast vs slow: $F(26,27) = 0.07$, $p < 0.001$, ratio of variances = 0.07, *95%CI* = [0.03, 0.15]), nor within subjects (t-test of per subject FID variance, fast vs medium: $t(32.94) = -6.12$, $p < 0.001$, $M_{fast} = 12.83$, $M_{medium} = 32.51$, *95%CI* = [-26.22, -13.14]; medium vs slow: $t(32.22) = -5.67$, $p < 0.001$, $M_{medium} = 32.51$, $M_{slow} = 90.44$, *95%CI* = [-78.74, -37.12]; fast vs slow: $t(27.59) = -7.91$, $p < 0.001$, $M_{fast} = 12.83$, $M_{slow} = 90.44$, *95%CI* = [-97.72, -57.5]). In particular, the slow predator condition had significantly larger variance in responses.

Importantly, these differences in response variability were a direct consequence of the experimental manipulation, that is, the manipulation designed to elicit "reactive" fear allowed a relatively shorter response window, and thus entailed increased urgency. For this reason, we do not consider the differences in response variability to be a confounding factor, but rather a necessary feature of the manipulation. However, to provide some evidence that the wider time window alone was not responsible for the relationship between FID and STAI-Y scores, we pooled the responses across the fast and medium predator types. The variance of median responses in this pooled data was not significantly different from that of the slow predator condition ($F(54,27) = 0.73$, $p = 0.329$, ratio of variances = 0.73, *95%CI* = [0.36, 1.37]). We performed a similar linear regression analysis with this pooled data, which showed that the interaction effect between the slow predator condition and STAI-Y scores remained significant ($t(1, 1662.48) = 10.11$, $p < 0.001$, $\beta = 0.56$, *95%CI* = [0.45, 0.67]) Overall, this suggested that this relationship between STAI-Y scores and FID was not simply due to subjects having a larger variance of responses in the slow predator condition.

Another trait factor that may have played a role in escape decisions is sensitivity to punishment, or behavioral inhibition[1]. Originally, this was proposed as a neurobiological substrate for anxiety[2], and is still routinely believed to play an important role in anticipating and assessing threats. We wished to investigate whether behavioral inhibition could also explain some of the variance in flight distance, above or beyond that of trait anxiety as measured by the STAI-Y. Firstly, we tested whether STAI-Y scores and BIS scores were related within our sample. A Pearson correlation showed the relationship between STAI-Y scores and BIS scores was not significant across participants ($t(26) = 0.61$, $p = 0.545$, $r = 0.12$, *95%CI* = [-0.27, 0.47]).

We then ran a mixed effects regression analysis similar to that used in the main text, with FID as the dependent variable, and predator type, STAI-Y scores, and BIS score as independent variables. The results of this analysis recapitulated the effects observed in previous model, including the significant interaction between STAI-Y scores and the slow predator condition ($t(2, 1655.87) = 5.09$, $p < 0.001$, $\beta = 1.01$, *95%CI* = [0.62, 1.4]). The model additionally revealed a significant interaction effect of BIS score and predator type for the slow predator condition ($t(2, 1655.68) = 3.25$, $p = 0.001$, $\beta = 1.79$, *95%CI* = [0.71, 2.88]). It also revealed a significant three-way interaction between BIS score and STAI-Y scores in the slow predator condition ($t(2, 1655.83) = -2.42$, $p = 0.016$, $\beta = -0.03$, *95%CI* = [-0.05, -0.006]). In addition to these key effects, the expected main effects for the medium ($t(2, 1655.68) = -1.99$, $p = 0.047$, $\beta = -17.38$, *95%CI* = [-34.47, -0.28]) and slow $t(2, 1655.68) = -9.01$, $p < 0.001$, $\beta = -79.13$, *95%CI* = [-96.35, -61.91] predator types were significant, while there were no significant effects for STAI-Y scores ($t(1, 24.24) = 0.55$, $p = 0.589$, $\beta = 0.22$, *95%CI* = [-0.56, 1.0]), BIS scores ($t(1, 24.28) = 0.46$, $p = 0.638$, $\beta = 0.52$, *95%CI* = [-1.62, 2.66]), the interaction of medium predator type and STAI-Y scores ($t(2, 1655.87) = -0.15$, $p = 0.88$, $\beta = -0.03$, *95%CI* = [-0.42, 0.36]), the interaction of medium predator type and BIS scores ($t(2, 1655.68) = 0.02$, $p = 0.987$, $\beta = 0.01$, *95%CI* = [-1.06, 1.08]), the interaction of STAI-Y scores and BIS scores ($t(1, 24.31) = -0.57$, $p = 0.572$, $\beta = -0.01$, *95%CI* = [-0.06, 0.03]), or the three-way interaction between the medium predator type, STAI-Y scores and BIS scores ($t(2, 1655.83) = 0.44$, $p = 0.657$, $\beta = 0.01$, *95%CI* = [-0.02, 0.03]).

As can be seen in the median split visualization plotted in Supplementary Figure 1, the relationship between STAI-Y scores and FID appears to be driven predominantly by those with higher BIS scores. However, it is critical to note that this result

should be interpreted with caution, as three-way interaction effects require substantially more experimental power to appropriately detect, and the sample size of this study was not chosen with this in mind. In general, this analysis suggests that the STAI-Y and BIS scores are separable, and that BIS similarly, but independently, influences FID.

We have also performed an exploratory fMRI analysis similar to the analysis of trait anxiety within the slow predator condition (see main text), but instead using BIS score. Here we find significant activity in the thalamus and right caudate (Supplementary Table 1).

We report the summary statistics for participants performance in the task, as a function of predator condition (Supplementary Table 2).

In the main text we reported the results of a PPI analysis showing modulation of brain areas by STAI-Y score from a ventral hippocampus seed. Given that literature has also pointed to interactions between dorsal hippocampus and mPFC[3], here we report the activation table for a similar analysis, using the entire hippocampus (Supplementary Table 3).

Here also report an analysis for the effect of STAI-Y scores within the slow predator condition similar to that presented in the main text, but using a contrast based on the control condition (Supplementary Table 4. Note that an identical analysis using the fast predator condition versus the control condition does not reveal any significant activation in any areas.

Supplementary tables

Supplementary Table 1. Activation table for 2nd level BIS score correlation for the slow versus fast predator contrast

Brain Region	Left/Right	Cluster Size	t-score	MNI coordinates		
				x	*y*	*z*
Thalamus	R	41	4.50	12	-12	0
Caudate	R	31	4.94	3	20	0
Note:				p<0.05, FDR corrected		

Supplementary Table 2. Summary of performance measures

Predator Type	N	Mean earnings (SD)	Mean escape proportion (SD)
Slow	28	889.89 (174.6)	0.9 (0.09)
Medium	28	563.52 (75.54)	0.88 (0.11)
Fast	28	267.56 (83.97)	0.74 (0.2)

Supplementary Table 3. Activation table for 2nd level STAI-Y score correlation for PPI (entire hippocampus)

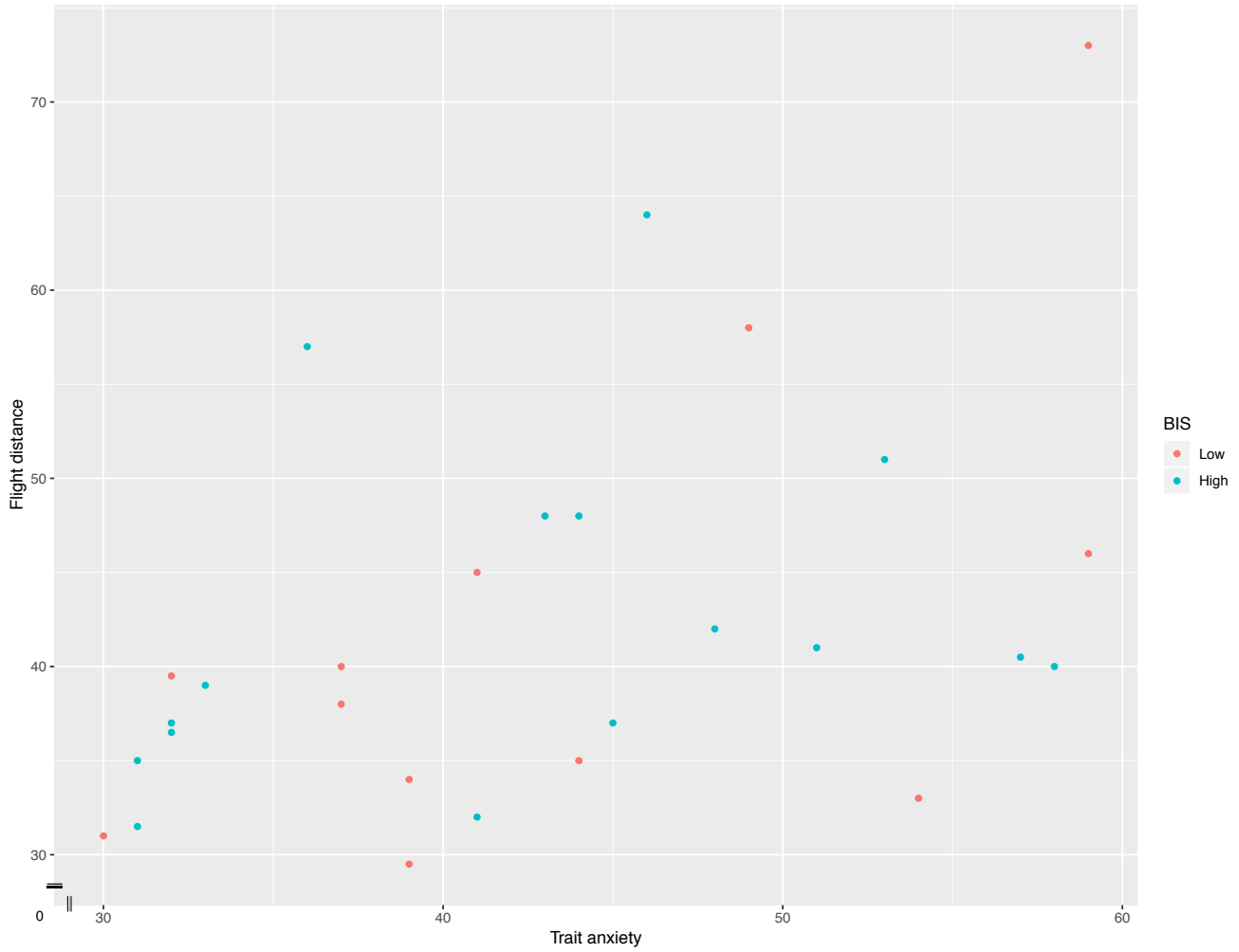
Brain Region	Left/Right	Cluster Size	t-score	MNI coordinates		
				x	*y*	*z*
Insula	L	77	5.37	-31	13	5
Medial Prefrontal Cortex	R	96	4.62	11	52	-14

Medial Prefrontal Cortex	L	83	4.77	-8	59	-12
Inferior Frontal Gyrus	R	63	4.91	48	15	-9
Parahippocampal Gyrus	R	57	5.56	26	-20	15
Amygdala	L	38	4.79	-24	-2	-15
Note:						p<0.05, FDR corrected

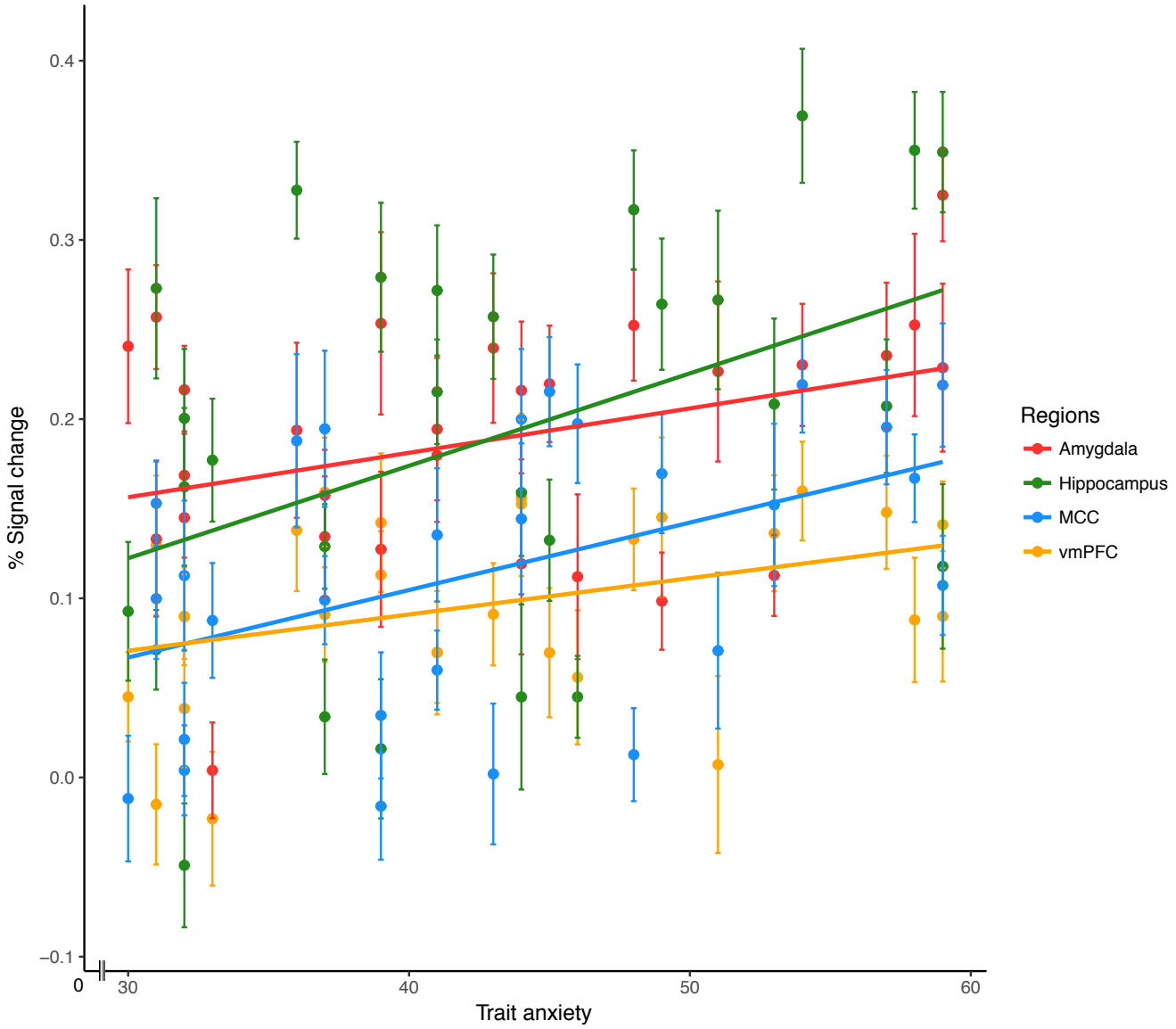
Supplementary Table 4. Activation table for 2nd level STAI-Y score correlation for the slow versus control predator contrast.

Brain Region	Left/Right	Cluster Size	t-score	MNI coordinates		
				x	*y*	*z*
Amygdala	L	42	7.70	-9	-24	-9
Hippocampus	L	25	6.26	-27	-39	-6
Medial Prefrontal Cortex	R	80	7.46	18	60	-6
Postcentral Gyrus	L	144	4.38	-57	-21	48
Insula	R	133	5.48	45	-24	24
Note:						p<0.05, FDR corrected

Supplementary figures



Supplementary Figure 1. Visualization of the interaction of STAI-Y and BIS on flight initiation distance within the slow predator condition. For interpretability, BIS scores have been divided into low and high by median split. A significant three-way interaction effect suggests that there is a positive relationship between trait anxiety and flight initiation distance for those with relatively high BIS scores.



Supplementary Figure 2. Post-hoc visualization of BOLD signal change as a function of trait anxiety in four brain regions. Note an increase in BOLD signal change as a function of trait anxiety in all regions. vmPFC, ventromedial prefrontal cortex; MCC, mid-cingulate cortex.

Supplementary references

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